Sustainable Bioprospecting: Utilizing Traditional Knowledge for Responsible Development of Insect-Derived Therapeutics

Abstract

This review article brings out the traditional medicinal knowledge of insects.Insects have been used in various forms of tribal medicine in different cultures around the world. It's important to note that the specific practices and beliefs related to tribal medicine and insect usage can vary significantly among different tribes and regions. Additionally, we should give importance to that tribal medicine is rooted in cultural traditions and beliefs, and its effectiveness differs among people. It's essential to approach these practices with respect and sensitivity, as they are part of indigenous knowledge systems and should not be exploited. Therefore, we should document the indigenous knowledge of the therapeutic use of insects and develop strategies for more sustainable preservation and development of a wealth of knowledge helpful for humans.

Keywords: Traditional medicine, Ethnoentomology, Insect medicine, Healing

Introduction

Ethnoentomological practices encompass a wealth of possibilities when it comes to insects as viable sources of food and raw materials for medicinal purposes. Tribal people, deeply rooted in their traditional knowledge, have long recognized the value of insects and utilize them not only in their home remedies but also for the well-being of their domesticated or semi-domesticated livestock[1]. Insects have been an integral part of folk medicine, where their therapeutic properties are harnessed to address various ailments and promote healing. These age-old practices highlight the intricate relationship between humans and insects, as people tap into the diverse healing properties offered by these creatures.

Nevertheless, despite the local understanding and utilization of insects, their wider significance in the context of global food security and pharmaceutical development is often overlooked. The potential benefits of insects as alternative protein sources and sustainable options for medication production remain untapped. Recognizing and appreciating the multifaceted potential of insects in ethnoentomological practices can lead to valuable insights, advancements in sustainable practices, and new opportunities for food security and healthcare. By embracing and further exploring the rich heritage of insect knowledge, we can unlock innovative solutions for a more sustainable and holistic future[2].

For centuries, insects have been revered in traditional medicine, but their medicinal importance remained an enigma, veiled in mystery. Only in recent times has scientific acknowledgment shed light on this fascinating field, entomo-ethnomedicine or ethnoentomology—the use of insects in traditional medicines. Drawing from ancient wisdom, these insect-based therapies

have been handed down through generations, offering intriguing insights into holistic healing practices. Despite their historical significance, this realm has yet to be fully explored, leaving a wealth of untapped knowledge and potential[3].

Embarking on this captivating journey, we delve into the wonders of insect-based traditional knowledge. From age-old remedies to the untamed potential of modern research, we unlock the secrets that insects hold as healers. As we unveil this uncharted territory, discover the hidden remedies nurtured by indigenous communities and the newfound scientific recognition that validates their ancient wisdom.

Historical roots of ethnoentomological healing

The roots of entomological medicine go far beyond written history. Ancient peoples themselves practiced these techniques, passing their knowledge down through generations via oral traditions and practical application. Now, let's explore the historical evolution of these entomological medicine practices.

"Insectotheology" (1699) introduced the idea that insects serve humanity[4]. However the use of insects in medicine dates back even further.

According to Weiss, 1946, the Ebers papyrus has several descriptions of medicines obtained from insect and spider[5].

For millennia, across diverse cultures, insects have played a surprisingly vital role in medicine. While they may not be the most aesthetically pleasing creatures, countless societies have harnessed their unique properties for healing. This tradition stands in stark contrast to the common perception of insects as mere annoyances[6].

Silkworms (*Bombyx mori* L., 1758) has been utilized in Chinese conventional medicinal drug for at least three thousand years[7]and the larvae of some flies have been identified for hundreds of years as useful organisms for the restoration of inflamed wounds[8].

In the first century A. D., Pliny the Elder recorded some entomotherapeuticals (insect-derived drugs) used by the Roman empire for the treatment of illness.

Insect remedies has been mentioned by Dioscorides, in his second book Materia medica[9]. As an example, quartan fever was treated by bedbugs; earache can be cured by cockroaches when ground with oil or cooked; bladder complaints can be cured by fried cicadas; anuresis of women can be treated by fumigation of locusts or grasshoppers, dried and taken with wine they were used against scorpion stings; dyer’s coccid of oaks was thought to be astringent for wounds.

Europeans believed that many kinds of insects have healing properties during the seventeenth century[10]. Traditionally May beetle, *Melolontha vulgaris* (L.), larvae oil was used topically on scratches, wounds and rheumatism and to treat anemiathat the adult beetles soaked in wine and used.

Although entomotherapy is an historic practice, it's miles nevertheless enormously unknown withinside the instructional world. In fact, as Holt already discussed in 1885, the development of clinical technology and the suppression of people information swept away perception withinside the medicinal characteristics of insects[11]. These herbal sources in peoples and drug treatments and their pharmacological importance, in addition to the conservation and sustainable use of medicinal insect species.

Exploring global traditions: Insect- based medicine

World cultures' traditional medical knowledge, passed down orally, has guided the discovery of commercially valuable biological resources, including insects with potential pharmaceutical applications. This knowledge of entomotherapy (insect-based medicine) is deeply integrated within these culture

Traditional medicines in India

Findings from the study of Samuel and his co-workers at 2016 revealed some of the indigenous medicines used by ancient people. Observing tribal people in Anamalai Hills, Pollachi block, Coimbatore district revealed unique food practices involving collecting honey bee hive, eggs (*Apis* sp.) with larvae from trees and rock hollows. Nest gathered, crushed by hand, yielding white milk juice. Juice fried, resulting in a white paste consumed by locals for improved physical health[12].

Winged termites known as "Easal" are consumed in villages for their nutritional benefits. They are typically eaten with rice after being cooked. This practice is common among tribal communities in Bodi hills, Theni district, and Sathyamangalam forest, Erode district, to enhance physical health.

In Kandhamal, Koraput, Sundergarh, Keonjhar, and Mayurbhanj districts of Orissa, tribal people consume crimson ants and termites, often roasting them for snacks or with rice. The local name for one type of crimson ant is "MUSURU," technically known as the weaver ant or Red ant. These ants nest in tree leaves, typically in mango trees. The nest, containing adults, larvae, and eggs, is collected from the leaves, heated, filtered, ground, and mixed with spices and water to make a soup (Rasam) believed to aid lactating mothers in milk production and alleviate cough and cold symptoms.

In Kodaikanal block, ants were discovered in the Palani hills area. In Orissa, ants carrying eggs were gathered from bushes, fried with salt, spices, and mustard oil, and consumed as food. Another insect called "kosutheni" was used for treating cough and cold. The adult nest with eggs was crushed

to extract juice, which was then mixed with spices to make a medicinal soup consumed by the local community.

A study in the Gudalur hills of the Nilgiri district explored the historical use of medicinal and edible insects by tribes in the Western Ghats. Honey bees (Egg/Larvae), Termites (Termite Soil), and red ants were identified as being used for both medicinal and nutritional purposes. Edible insects offer natural and sustainable food sources that provide nutritional, economic, and ecological benefits to rural communities.

Singh and Padmalatha's study sheds light on the rich tradition of insect-based medicine in Tirunelveli district. The documented use of various insects for a range of health problems highlights the potential for further research into the therapeutic properties of insects. This exploration could lead to the development of novel and effective medicines. Some of them are given below[3].

Honey bee: (*Apis spp*., Apidae: Hymenoptera)

Honey, bee wax, propolis, and bee venom are well-established medicinal products. The study area utilizes honey from *Apis dorsata* (Rock bee), *Apis cerana indica* (Indian bee), and *Apis florea* (Little bee). Rock bee honey, collected during November-December, is particularly valued for its perceived curative properties. Honey finds application in treating various ailments, from daily consumption for general health to wound healing and as a vehicle for herbal cough remedies. Interestingly, a combination of honey and cleaned termites is used for childhood respiratory problems. Honey from *Apis florea* is considered especially effective for respiratory issues, while bee wax finds use in treating fistulas, piles, and rheumatic pain.

Other Medicinal Insects

The review details the use of various other insects for specific purposes. Crushed Cucurbita bugs (*Aspogonopusjanus*) are applied topically with herbal extracts for leucoderma patches. Silkworm (*Bombyx mori*) cocoons, in ash form, act as a styptic, tonic, and astringent for menstrual disorders and diarrhea. Traditionally, silkworm cocoons were also believed to possess aphrodisiac properties and treat eye infections. Cochineal insects (*Dactylopius coccus*) are used in powdered form to treat whooping cough and potentially act as a sedative. Velvet ants (*Dasymutilla occidentalis*) are a source of nerve tonic and antispasmodic medicine, while household ants (*Doryluslabiatus, Componotuscompressus,* and *Monomorium spp.*) are believed to strengthen the nervous system when consumed with honey.

Weaver ant (*Oecophyllasmaragdina*) eggs are used in traditional medicine for various ailments, including tetanic fever, earaches, fevers, and malaria. Additionally, the secretion used by these ants to build their nests exhibits antibacterial properties. The ootheca of the preying mantis (Hierodula ocellata) is powdered and administered with milk for pneumonia.

Lac insects (Lacciferlacca) provide lac resin, used in shellac production. Shellac, with its germicidal, febrifuge, and astringent properties, finds applications in treating various conditions like caries, chronic fevers, rheumatism, liver problems, cough, epilepsy, and neural issues.

Blister beetles (*Mylabris* spp.) are a source of cantharidin, used for treating urinary problems, as a diuretic, and for topical applications like vesicants and counter-irritants. Additionally, their powder is used in hair fall and headache remedies.

Finally, termites (*Macrotermis* spp.) are not only consumed as a food source but also used medicinally. Termite swarms are roasted and consumed, while termite-infused honey is believed to improve vitality and treat respiratory problems and urinary issues. Termite mound soil is used for treating skin diseases, with some traditional healers even offering "Termite mount soil baths" for various ailments.

A study by Bhowate and Kumar in 2020 explored tribes and rural communities living on the Satpura Plateau in Madhya Pradesh, India, traditionally use insects and insect products for both medicine and food. Conducted from June 2017 to December 2018, the ethnoentomological investigation documented ten insect species employed for treating sixteen ailments[13]. These ailments included common conditions like pneumonia (treated with mulberry silkworm ash), general wounds (treated with red wasp), dog bites (treated with grasshopper), and snake bites (treated with swallowtail butterfly larvae). Interestingly, the study also revealed the consumption of mashed Red Weaver Ants as a food source when available. This research highlights the presence of a rich tradition of ethnoentomology in the Satpura Plateau. The documented use of various insects for such a diverse range of health concerns warrants further exploration of the potential therapeutic properties these insects may possess. Such investigations could pave the way for the development of novel medical treatments.

A study in Mayurbhanj district, India, highlights the multifaceted ancient treatmentwith the Red Weaver Ant (*Oecophyllasmaragdina*) among ethnic people[14]. This knowledge, passed down verbally through generations, faces the risk of disappearing due to a decline in interest among younger age groups.

Interestingly, the Red Weaver Ant serves as both a food source and a potential medicine. Tribes consume them directly or prepare chutneys, incorporating them into their diet. Scientific analysis suggests these ants are a good source of carbohydrates, protein, and essential nutrients. The study also explores the medicinal uses of Red Weaver Ant bites for treating jaundice. Formic acid present in the ant's venom is believed to convert bilirubin to biliverdin in the blood, potentially aiding recovery. Additionally, reports suggest antimicrobial properties against bacteria and Candida species. Similar to the Asian Harvester Ant, the Red Weaver Ant might possess bioactive metabolites with

therapeutic potential. Tribal knowledge indicates its use against enteric infections and whooping cough, warranting further scientific investigation.

This research emphasizes the ecological and social importance of Red Weaver Ants. Extensive ethnoentomological knowledge held by tribes can raise awareness about the potential health benefits of these insects. However, unsustainable harvesting practices to meet the demands of urban markets threaten rural biodiversity. This study underlines the need to document and preserve traditional ecological knowledge while exploring sustainable ways to utilize Red Weaver Ants for food, medicine, and economic benefits.

A 1999 survey by Oudhia in Chhattisgarh documented the traditional use of the predatory mite (*Trombidiumgrandissimum*) as a treatment for over ten ailments, including malaria, urinary problems, and paralysis. This highlights the potential of under-explored insects in traditional medicine[15].

In a Madhya Pradesh survey conducted by Oudhia at 2001, revealed that traditional uses of *Helicoverpaarmigera* larvae by villagers for over 50 ailments. Powdered larvae were used as a tonic for common ailments while fresh extracts were used to treat wounds. This knowledge is mainly held by older generations, highlighting a potential decline in traditional insect medicine[16].

These studies across India reveal a rich tradition of entomotherapy (insect-based medicine) among tribal communities. From honeybees and termites to weaver ants and silkworm cocoons, a diverse range of insects are used to treat various ailments. This knowledge, often passed down verbally, faces threats of disappearing with younger generations. Further research into the documented uses and scientific validation of these practices can unlock the potential of insects for novel and sustainable medical solutions.

Traditional medicines in China

China boasts a rich tradition of incorporating insects into both food and medicine. Historical references dating back 3,000 years mention the medicinal use of silkworms, while bees and lac insects were valued for their healing properties as early as the Xizho Dynasty (1100-771 BC).

"ShennongBencaojing," a 2,000-year-old cornerstone of Chinese medicine, documented 21 insect species with medicinal value. These insects were categorized based on their perceived properties and potential dangers:

Grade 1: Considered safe for consumption. Examples include bee larvae, wax, honey, and mantis egg cases.

Grade 2: Deemed partially poisonous but safe in moderation. Examples include honeycomb, cicadas, and silkworms.

Grade 3: Considered highly poisonous and suitable only for occasional, limited consumption. Examples include certain beetles, moths, cicadas, and cockroaches.

This categorization was based on practical experience rather than scientific analysis, as the toxicity levels of insects couldn't be determined in ancient laboratories. While this system offered some practical guidance, it lacked a solid scientific foundation.

Over time, the knowledge base of medicinal insects expanded. "MingyiBielu" (420-589 AD) added nine new insect species, followed by "Compendium of Materia Medica" (1587) with 73 entries. The supplement to this compendium, compiled during the Qing Dynasty (1616-1911 AD), further expanded the list to 105 insects used for medicinal purposes.

- Ancient China's classification of insects for medicinal purposes faced limitations. Insect names were often confused, leading to misunderstandings. For instance, the "ShennongBencaojing" treated bee larvae, honey, wax, and honeycomb as separate insects, while modern science recognizes them as different stages and products of the same bee species.

- Despite these limitations, traditional knowledge has undergone revisions. Modern "Handbooks of Chinese Medicinal Animals" list 143 medicinal insects categorized into 13 orders and 48 families, reflecting a more refined understanding.

- The use of insects and other arthropods in Chinese medicine extends beyond insects themselves. Evidence suggests a diverse range of medicinal applications[17]. For example, Chinese communities in Malaysia utilize the dried excreta of walking sticks (order Phasmida) mixed with herbs to treat asthma, stomachache, and muscle pain[18].

Folkloric Treatment: Children are sometimes given baked cattle ticks (*Boophilusmicroplus*) as a remedy or preventative measure against chickenpox[9].

Cordyceps and Caterpillars: Caterpillars infected with the fungus *Cordyceps sinensis* are believed to strengthen a weakened body after illness or overexertion fungus contains potentially bioactive compounds like cordycepin and ophiocordin[19].

Modern Focus: Research has narrowed down the vast array of medicinal insects to a select few for in-depth pharmacological studies. Current research focuses on species like *Malaphis chinensis*, *Bombyx mori* (silkworm), *Hepialusarmoricanus*, *Mylabriscichori*, and *Buthusmartensii* (scorpion)[7].

These examples highlight the diverse applications of insects in Chinese medicine. Today, significant progress is being made in this area. Researchers are not only expanding the inventory and classification of these biological resources but also isolating specific therapeutic compounds with potential medicinal benefits.

Ant medicine is considered beneficial for liver issues, impotence, and cancer-related symptoms like pain, digestion, and white blood cell count[20]. Traditional beliefs suggest that consuming ants can rejuvenate the elderly and increase milk production in women.

In China and Tibet, royalty and others have traditionally consumed, *Polyrhachisvicina* Roger, as a tonic beverage for immune system support and rheumatoid arthritis relief[20]. This practice may hold some scientific basis, as research suggests ant venom might reduce inflammation in rheumatoid arthritis by impacting proteins within the body's complement system[21].

Yin-Yang Theory and Hypertension:

TCM views hypertension as an imbalance between yin (blood, viscera) and yang (vital energy, back). Treatment aims to restore balance by reducing excess yang and nourishing yin[22].

Case Study: A 61-year-old woman with hypertension, dizziness, tinnitus, and other symptoms was treated by Shi Jinmo, a renowned TCM physician, using a two-stage approach with insect inclusions.

First Prescription: This stage aimed for immediate relief. Ingredients included:

Minerals: Magnetite, hematite, sea-ear shell (potentially for balancing yin and yang).

Herbs: Eucommia bark (potential blood pressure lowering), Achyranthes root, Ginkgo seeds (known circulatory benefits), Polygala root, chrysanthemum flower (known sedative effects), Ophiopogon root (yin nourishing), Tuckahoe (diuretic), Tribulus fruit, and others.

Insects: Cicada exuviae (potentially for tinnitus based on traditional belief, not proven medicinal value).

Second Prescription:

This stage focused on addressing the root cause. Ingredients included:

Herbs: Similar herbs to the first stage with increased focus on yin nourishing (Ophiopogon root, Rehmannia root) and blood pressure regulation (Eucommia bark, Tribulus fruit).

Insects: Cicada exuviae (potentially for tinnitus based on traditional belief, not proven medicinal value).

The patient reportedly recovered fully after taking the second prescription in pill form.

This case study demonstrates the use of various insects and herbs in TCM for hypertension treatment, often based on philosophical concepts like Yin-Yang balance. While some practices may lack a strong scientific basis (e.g., cicada exuviae for tinnitus), others warrant further investigation.

Exploring the bioactive properties of insects used in TCM has the potential to reveal novel therapeutic applications for hypertension and other ailments.

Traditional medicines in Africa

Across Africa, insects have found a niche in traditional healing practices. In southwestern Nigeria, for instance, infected feet are treated by applying the gut contents of mole crickets (*Gryllotalpa africana*Beauvois)[23]. Honey, according to[24], serves as a common remedy for coughs and stomach ailments throughout the continent. He further notes that traditional healers frequently use honey as a base for administering various plant-based medicines. Interestingly, Somalia even utilizes the mandibles (jaws) of termite soldiers (*Termes bellicosus*) to stitch wounds. In the state of Kwango, Zaire, clay nests made by mud daubing wasps of the genera Synagris and Sceliphron (5 Pelopoeus) are ground and the clay is eaten by pregnant women. Apparently, this practice provides lime to the fetus[25].

Van Huis (1996) documented the practice of pregnant women in Africa consuming clay from termite mounds or runways built on trees and poles. This suggests a potential use of insect-related materials beyond the insects themselves[24].

Antonio reported on the traditional use of 18 insect species in Zaire (now the Democratic Republic of the Congo). One example involves treating severe headaches with grasshoppers (mpaylaar). The healer crushes dried grasshoppers and ashes, mixes them with a touch of salt, and makes small cuts on the patient's neck and forehead. This mixture is then applied to the wounds, causing a stinging sensation that supposedly necessitates extended sleep. This treatment reportedly lasts at least three days[26].

Mbata's research in Zambia revealed a diverse range of arthropods used in traditional medicine, encompassing insects, arachnids, crustaceans, millipedes, and centipedes. He identified ten insect orders as sources for these remedies. Interestingly, six cockroach species are used to treat boils and wounds, while the grasshopper *Acrida bicolor* is employed for hypertension. Additionally, termite species *Cubitermes*spp. and *Macrotermes*spp. find application in treating heart pain and childhood malnutrition, respectively[27].

Van der Waal[28]documented practices among the Venda people of South Africa. They traditionally treated bedwetting in children by feeding them fried bapu grasshoppers (*Lamarckiana* spp.). Similarly, nightmares were addressed by administering a concoction of ground, dried bapu grasshoppers mixed with warm water.

These examples showcase the diverse and fascinating ways in which insects have been integrated into traditional healing practices across Africa. From treating wounds and headaches to

addressing childhood ailments and sleep disturbances, insects play a significant role in the medicinal repertoire of various African cultures.

Traditional medicines in Brazil

Brazil boasts a rich tradition of entomotherapy, the use of insects in medicine. Documented since colonial times across 13 states[29], this practice encompasses a diverse range of insects for various ailments. In the northeastern state of Bahia alone, over 50 insect species are utilized in folk medicine[30].

Hymenoptera, the order containing bees, wasps, and ants, is particularly prominent. The Pankarare' Indians and rural populations, for example, use mud wasp nests to treat mumps and honey from specific bee species to soothe sore throats and counter snake or rabies bite[30]. Interestingly, a concoction of Plebeia bee wax and urine is used for diabetes, while burnt wax inhalation finds application in stroke treatment.

Grasshoppers also play a role. Herbalists recommend a tea brewed from toasted grasshopper exoskeletons for skin diseases and stroke recovery[31]. Additionally, pow3dered grasshoppers feature in teas for asthma and hepatitis[30].

Beyond native insects, the introduced *Palembusdermestoides* beetle, nicknamed the "love bug" for its supposed aphrodisiac properties, is consumed to treat asthma, arthritis, tuberculosis, and sexual impotence[32]. Honey from various bee species finds use in treating coughs, while the legs of a spider wasp and a bloodsucking bug (*Triatoma* sp.) are transformed into teas for asthma and heart ailments respectively. Even crushed stink bugs are used to clear nasal congestion.

Entomotherapy extends beyond medicinal purposes. In the city of Tanquinho, crushed houseflies are applied to combat baldness, while an arapua insect's scutellum is used in an infusion for acne treatment[33].

Further north, in Alagoas, additional insect-based remedies exist. Earaches are addressed by a white mass extracted from the palm beetle *Pachymerusnucleorum*, while honey and rum concoctions tackle mumps[34]. Leaf-cutting ant teas address dizziness, and the sting of the Dinoponera ant is believed to strengthen the penis.

Brazil's vibrant tradition of entomotherapy highlights the potential of insects as medicine. The sheer diversity of species employed across various ailments, from Hymenoptera like mud wasps and stingless bees to grasshoppers and even introduced beetles, suggests a deep understanding of their properties among traditional healers. However, further scientific exploration is crucial to validate the efficacy of these practices and identify potential bioactive compounds, while ensuring sustainable harvesting methods to protect insect biodiversity for future generations.

Insect Nests and Dwellings as Remedies:

India: The nest of the wasp *Eumenes* sp. (Formicidae) finds application in treating headaches. A paste made from the nest is applied topically to the forehead. In some cases, the nest is boiled with coconut oil for topical application. Additionally, wasp nests are used to treat wasp stings themselves, with a water-based paste applied to the affected area.

Brazil: Rural communities traditionally use a paste made by dissolving mud wasp (Sphecidae) nests in water for treating mumps.

Africa: The nests of mason and dauber wasps are used in various ways: a paste rubbed on the belly is believed to address spleen issues, while oral consumption of the paste is thought to cure sinusitis.

Insects as Hosts for Medicinal Fungi:

Caterpillars as Fungal Partners: The caterpillars of *Hepialusoblifurcus* (Hepialidae) serve as hosts for the fungus *Cordyceps sinensis*. This combination is believed to strengthen and revitalize a person's system after illness or overexertion. The fungus contains potentially bioactive compounds like cordycepin and ophiocordin.

Leaf Cutter Ants and Fungal Allies: Fungi cultivated by leafcutter ants are known to produce various therapeutically valuable compounds.

These examples showcase the ingenuity of traditional medicine in utilizing not just insects themselves, but also the materials they create and the symbiotic relationships they form with other organisms like fungi.

Conclusion:

Despite the widespread aversion many people feel towards insects, these tiny creatures hold immense potential for medical breakthroughs. Through millions of years of adaptation to plants and the threats they pose, insects have developed a vast arsenal of defensive chemicals, making them a virtually inexhaustible resource for pharmacological research. This potential remains largely untapped, with medicinal insect species receiving considerably less attention compared to other sources. However, the tide may be turning. The growing interest in natural and sustainable medicine, coupled with the increasing challenge of antibiotic resistance, has spurred renewed exploration into the world of insect-derived medicine. Insects offer a multitude of advantages: they are relatively easy and inexpensive to breed, require minimal space, and possess unique biochemical pathways that can yield novel therapeutic compounds. Research in this area is already showing promise, with insect-derived substances exhibiting potential for treating cancer, infections, and even neurological disorders. As scientific understanding grows, so too does the possibility of integrating traditional insect-based remedies from cultures around the world into modern medicine. Learning from old

wisdom and using new science, we can discover amazing things from insects, transforming them from objects of disgust into powerful allies in the fight for human health. This shift in perspective holds the promise of a healthier future, offering a new wave of therapeutic solutions derived from a sustainable and readily available source.

Consent for publishing

Consent has been obtained from both the authors for publishing the manuscript.

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